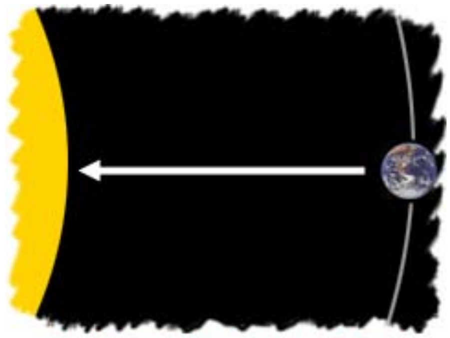
Name ______________________________ Period________

Forces of Nature

Forces are a big part of physics. Physicists devote a lot of time to the study of **forces** that are found everywhere in the universe. The forces could be big, such as the pull of a star on a planet. The forces could also be very small, such as the pull of a nucleus on an electron. Forces are acting everywhere in the universe at all times and can be defined as a push or a pull on an object.



THE GRAVITATIONAL PULL OF THE SUN IS ONLY ONE TYPE OF FORCE.

Examples of Force

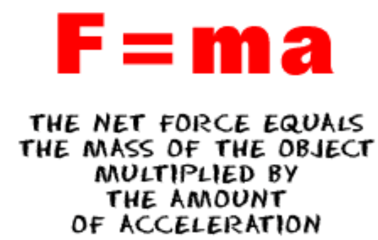
Picture a ball sitting on a field and then someone kicking it, a force would have acted on the ball. As a result, it would go bouncing down the field. There are often many forces at work. Physicists might not study them all at the same time, but even if you were standing in one place, you would have many forces acting on you. Those forces would include **gravity**, the force of air particles hitting your body from all directions (as well as from wind), and the force being exerted by the ground (called the **normal force**).

THE FORCE OF GRAVITY CAUSES THE BALL TO RETURN TO THE SURFACE.

Let's look at the forces acting on that soccer ball before you kicked it. As it sat there, the force of gravity was keeping it on the ground, while the ground pushed upward, supporting the ball. On a molecular level, the surface of the ball was holding itself together as the gas inside of the ball tried to escape. There may have also been small forces trying to push it as the wind blew. Those forces were too small to get it rolling, but they were there. And you never know what was under the ball. Maybe an insect was stuck under the ball trying to push it up. That's another force to consider.

If there is more than one force acting on an object, the forces can be added up if they act in the same direction, or subtracted if they act in

opposition. Scientists measure forces in units called **Newtons**. A newton is defined as the force that would give a mass of one kilogram an acceleration of one meter per second per second.

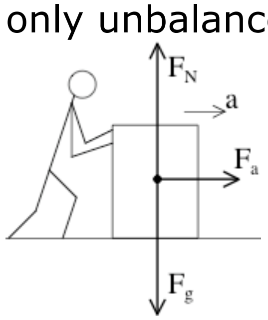


A Formula of Force

There is one totally important formula when it comes to forces, **F = ma**. That's all there is, but everything revolves around that formula. "F" is the total (net) **force**, "m" is the object's **mass**, and "a" is the **acceleration** that occurs. As a sentence, "The net force applied to the object equals the mass of the object multiplied by the amount of its acceleration." The net force acting on the soccer ball is equal to the mass of the soccer ball multiplied by its change in velocity each second (its **acceleration**). Do you remember the wind gently blowing on the soccer ball? The force acting on the ball was very small because the mass of air was very small. Small masses generally exert small forces, which generally result in small accelerations (changes in motion).

Forces and Vectors

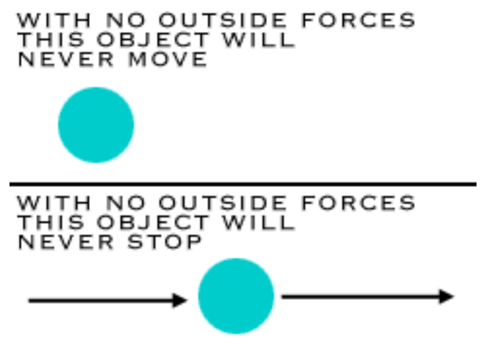
A **force vector** describes a specific amount of force that is applied in a specific direction. Looking at the image below it is easy to see that the force of gravity (force pointing down) is equal to the normal force (pointing up) because they are acting on the same object and are equal in value and opposite in direction these forces cancel out. The Net Force is the force being applied to the box to the right and is the only unbalanced for in the picture.



Newton's Laws of Motion

There was this fellow in England named **Sir Isaac Newton**. A little bit stuffy, bad hair, but quite an intelligent guy. He worked on developing **calculus** and **physics** at the same time. During his work, he came up with the three basic ideas that are applied to the physics of most **motion** (NOT **modern physics**). The ideas have been tested and verified so many times over the years, that scientists now call them **Newton's Three Laws of Motion**.

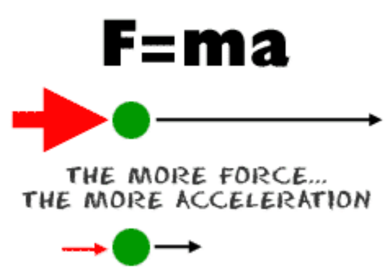
First Law



The first law says that an object at **rest** tends to stay at rest, and an object in **motion** tends to stay in motion, with the same direction and **speed**. Motion (or lack of motion) cannot change without an unbalanced **force** acting. If nothing is happening to you, and nothing does happen, you will never go anywhere. If you're going in a specific direction, unless something happens to you, you will always go in that direction. Forever.

You can see good examples of this idea when you see video footage of **astronauts**. Have you ever noticed that their tools float? They can just place them in space and they stay in one place. There is no interfering force to cause this situation to change. The same is true when they throw objects for the camera. Those objects move in a straight line. If they threw something when doing a spacewalk, that object would continue moving in the same direction and with the same speed unless interfered with.

Second Law

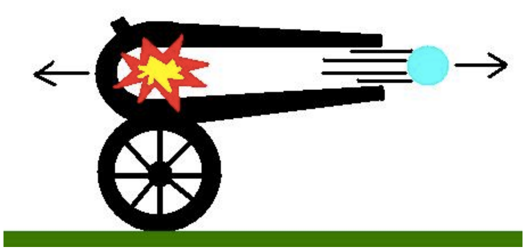


The second law says that the **acceleration** of an object produced by a net (total) applied force is directly related to the **magnitude** or size of the force, the same direction as the force, and

inversely related to the mass of the object (inverse is a value that is one over another number... the inverse of 2 is 1/2). The second law shows that if you exert the same force on two objects of different mass, you will get different accelerations (changes in motion). The acceleration on the smaller mass will be greater (more noticeable). The effect of a 10 newton force on a baseball would be much greater than that same force acting on a truck. The difference in acceleration is entirely due to the difference in their masses.

Third Law

The third law says that for every action (force) there is an equal and opposite reaction (force). Forces are found in pairs. Think about the time you sit in a chair. Your body exerts a force downward and that chair needs to exert an equal force upward or the chair will collapse. It's an issue of symmetry. Acting forces encounter other forces in the opposite direction. There's also the example of shooting a cannonball. When the cannonball is fired through the air (by the explosion), the cannon is pushed backward. The force pushing the ball out was equal to the force pushing the cannon back, but the effect on the cannon is less noticeable because it has a much larger mass. That example is similar to the kick when a gun fires a bullet forward.



1. Define Force: ________________________________

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2. According to Newton's first law of motion, an object in motion will ____________ _____ __________ and an objet at rest will _________ ______ __________ unless acted upon by an outside _________.

3. According to Newton's second law of motion, the acceleration of an object is dependent on two things: _____________ & _____________.
4. According to Newton's third law of motion, forces always come in ____________. These are known as action reaction forces or action reaction pairs.